

NOTES ON THE BIOLOGY OF PARAPHELINUS SPECIOSISSIMUS GIRAULT.

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It is well known that the Chalcidoids of the Tribe *Aphelinini* are among the most important parasites of Scale Insects, particularly of the *Diaspinæ*, and that they also parasitize *Aphididæ* and *Aleyrodidæ*. The only exceptions appear to belong to the genus *Paraphelinus*, erected by Perkins in 1906 (Bull. 1, part 8, Report of Work of the Experiment Station of the Hawaiian Sugar Planter's Association, 1906, p. 264) to contain his *P. xiphidii*. In describing the species *P. tomaspinis*, Dr. Howard has given a compact summary of the facts known regarding the biology of this genus (Proc. Ent. Soc. Wash., XVI, 1914, pp. 81-82), which is as follows:

"Perkins's *P. xiphidii* was reared from the eggs of *Xiphidium varipenne* Swezey. The only other species so far discovered, viz.: *P. speciosissimus* Girault (Journ. N. Y. Ent. Soc., 1911, p. 181) and *P. australiensis* Girault (Archiv fur Naturgeschichte, 1913, pp. 74-75, Ab. A. 6 heft), were both described from single captured specimens, so that their host relations are unknown. The receipt of the new species here described from Mr. P. L. Guppy, of Trinidad, who reared it from the eggs of the sugar cane leaf-hopper, *Tomaspis varia*, makes it probable that all species of this interesting genus are parasites in the eggs of Orthoptera and Homoptera that are inserted in twigs or canes. This would be an unique feature in *Aphelinine* biology (the other forms all ovipositing only in Coccidæ, Aphididæ and Aleyrodidæ) were it not for the old disputed species *Agonioneurus locustarum* Giraud (placed in *Aphelinus* by Dalla Torre) and which was described by Dr. J. Giraud in his Memoir on the insects which live upon the common rose (Verh. d. Zool.-Bot. ges. Wien., Vol. 18, 1863, pp. 1278-1279) and which he reared from the eggs of *Xiphidium fuscum* F. It seems to me quite possible that in the old *A. locustarum* we may have another species of *Paraphelinus*. There is nothing in the original description which would seriously deny this guess, except the absence

of the hairless discal streak on the primaries, and this is obscure in the species about to be described."

We were quite surprised to find last July that an *Aphelinine* was emerging from Hessian Fly puparia. These have been determined by Mr. A. B. Gahan, of the Bureau of Entomology, as *Paraphelinus speciosissimus* Girault. As will be noted from the above quotation, it requires only a slight elaboration of Dr. Howard's theory to include as a host for this genus the Hessian Fly, whose puparia resemble superficially the eggs of an Orthopterous insect and are embedded in the stems of wheat.

The original specimens upon which the present data are based were secured from wheat stubbles collected by Mr. P. R. Myers of the Bureau of Entomology. The puparia were removed from these stubbles and placed in cages containing nothing else. Adults reared from these puparia were used by the writer in experimentally parasitizing other puparia known to be absolutely free from any parasites, and three more successive generations have thus been reared from the original parents. The rearing has been conducted at Hagerstown, Md., and all data here given apply to laboratory conditions at that point.

DISTRIBUTION.

Girault's original specimen was collected on a granary window at Urbana, Ill. In spite of the fact that we have reared large numbers of Hessian Fly puparia from various points in Pennsylvania, Maryland, Virginia and West Virginia, we have thus far secured this parasite only from the following six localities in central Pennsylvania: Linden, Montoursville, Muncy, Montgomery, Northumberland, and Andersonburg. The first five localities are in two adjoining counties along the Susquehanna River, where a serious outbreak of Hessian Fly occurred. The last locality is about fifty miles southwest from Northumberland, and here only about 31% of the stubbles were infested by the Hessian Fly. Out of a total of 3165 puparia secured from all of these localities, only 17, or a little more than .005%, were parasitized by this Chalcidoid. Some fields in each locality yielded none of these parasites, while in the other fields the percentage of parasitization varied from 0.14% at Andersonburg to 3.2% in one field at Muncy. In the latter field Mr. Myers estimated that 65% of the stubbles were fly-infested.

ADULT.

The adults are beautiful little insects with head and abdomen almost entirely black, thorax and legs chiefly light yellow, a dark band across the front wings and ovipositor exerted. The females average about 0.8 mm. long; the males, about 0.5 mm.

This species is a primary multiple parasite of the Hessian Fly. It has been demonstrated repeatedly that it is a primary parasite, not only by rearing it from the Hessian Fly, but by experimentally parasitizing Hessian Fly puparia known to be free from parasites. It would seem to promise much as a primary parasite of this host because several adults usually emerge from a single host. This is not due to polyembryony but to multiple egg deposition, as shown by the recovery by dissection of eggs deposited in puparia. The number of adults emerging from a puparium varies from 1-10, with an average of about 7, for puparia experimentally parasitized. This average is considerably lower under field conditions as they obtained last year. Eleven eggs have been dissected from one host parasitized in the laboratory, and another contained twenty-one living larvæ, two dead larvæ and two dead eggs. In this case the evident excessive parasitization had already begun to right itself.

The adults emerge through a round hole in the middle region of the puparium, and usually there is a single one. Sometimes two exit holes are cut, and occasionally three. When there is a single exit hole it is frequently much larger than would seem necessary. The exit holes vary in size from 0.2 mm. to 0.45 mm. with an average for ten puparia of 0.33 mm., while according to measurements made by Mr. Myers the largest diameter of the thorax averaged 0.24 mm. for the females, while in the males it is only 0.18 mm.

All adults usually emerge from a puparium about the same time, but occasionally they may emerge throughout the day, and in one case the last female emerged two days later than the others. In many cases both sexes emerge from the same puparium. In laboratory cages where both sexes were introduced, about 18% of the progeny were males. In one cage into which only unfertilized females were placed, all of the progeny were males. It is apparent from this that the species is

arrhenotokous, but there has been no opportunity for carrying parthenogenesis through several successive generations.

When there is opportunity, mating occurs shortly after emergence, and there is little doubt that one male is capable of fertilizing several females. Oviposition may begin very shortly after emergence. In fact, it is difficult to remove females from cages and make sure that they have not oviposited in other puparia in the same cage. The females continue oviposition for several days. In cages, adults usually do not live longer than three to six days, but if they do not oviposit their life may be much longer. In one cage they have lived seventeen days. They feed on sugar solution, but have not been observed feeding at punctures in the host made by the ovipositor.

The females will oviposit in puparia concealed in young wheat plants and in dry dead stubbles as well as in uncovered puparia. It seems to make no difference whether the puparium contains a larval or a pupal host, as both stages are successfully parasitized.

EGG.

The eggs of this parasite are deposited in the body cavity of the host. Ten eggs averaged 0.166 mm. in length by 0.057 mm. in greatest width. They are white and translucent and the chorion is devoid of sculpture. The eggs are ovate and stalked, the stalk being about one-third the length of the egg proper. The stalk is attached excentrically at one end of the egg, slightly curved toward its main axis, and is wide at the base tapering rapidly to a rather bluntly rounded apex.

LARVA.

Nearly grown larvæ are yellowish white with the exception of the light brown mandibles. The head is about twice as wide as long and bears at each antero-lateral region a large conical process directed forward. These lateral projections are peculiarly striking and may be simply a means of exposing more surface to the fluids of the host. The front between these processes is almost straight, but there is a decided concavity ventrally between the lateral processes. The mandibles are simple, conical, sharply pointed, slightly curved, and the tips slightly overlap. The mouth opens just below them. The body apparently consists of thirteen segments. These are distinct in the anterior region but posteriorly are difficult to distinguish.

There is a pair of short tubercles on the ventral region of the prothorax and these are evidently vestigial prothoracic legs. No spiracles have been observed, but they probably do not open up until just before pupation. The body is devoid of hairs. The alimentary canal is a large sac closed behind and filled with yellowish material. There is a posterior anal notch but the proctodæum apparently lacks a lumen. A pair of salivary glands may be seen starting back from a common duct originating ventral to the mouth cavity. While alive the larvæ exhibit a rhythmic opening and closing of the mouth, but the mandibles are not moved while this is in progress, and periodic swallowing movements occur.

In full grown larvæ the body is somewhat shorter and broader and the processes on the head slightly less conspicuous. Larvæ at this stage are about 1 mm. long and 0.3 mm. wide.

Pupation takes place inside the skin of the host. The latter is rounded out into a more or less elliptical cell and becomes dry and light brown in color. The larvæ have a strong tendency to arrange themselves before pupation with their heads directed toward the center of this cell, and in this cell just prior to pupation they void their excrement, which consists of numerous dark reddish brown disks.

PUPA.

The pupa when first formed, is white with an elongate orange spot, showing through the middle of the dorsum of the abdomen. The average of four pupæ gave a length of 1.063 mm. by 0.356 mm.

LIFE HISTORY.

Accurate data for the length of the various stages of this parasite have not been secured. However, in one cage where the adults began to oviposit in host puparia on July 29th, larvæ almost full-grown in hosts almost entirely consumed were dissected out on August 3d, after a period of only five days. This shows that at this season development is very rapid and that the egg and larval stages are very short. In another cage numerous pupæ and no larvæ were dissected August 4th from host puparia into which parasites began to oviposit July 24th. Adults emerged from these pupæ August 13th and 14th, showing that the pupa stage required at least nine days. From these and other cages it was found that complete development from

oviposition to emergence required from eighteen to twenty days at this season of the year. Developmental processes slow up with the approach of cold weather. We do not know the number of generations per year, but beginning July 24th, we ran one cage in which three generations matured by October 19th, the first beginning to appear August 20th, the second September 14th and the third on the date mentioned. Assuming that the parent generation required twenty days, there could be four generations from July 4th up to the last of October. Under field conditions at the points where the original specimens were collected, this last generation might not be produced.

In any event, there is time enough in one season for an enormous multiplication of this parasite. Puparia collected shortly before emergence of the host would probably show a much higher percentage of parasitism than that shown by our figures. Consequently, *Paraphelinus speciosissimus* may prove in the future to be an important agent in the control of a serious outbreak of the Hessian Fly and the fact that one host may serve to develop as many as ten adults would indicate that it could maintain its numbers at a relatively high level during seasons when the host is scarce.